*J. Raptor Res.* 31(1):71–76


# ROLE OF REFUSE AS FOOD FOR MIGRANT, FLOATER AND BREEDING BLACK KITES (*MILVUS MIGRANS*)

GUILLERMO BLANCO
*Departamento de Biología Animal, Universidad de Alcalá de Henares, Alcalá de Henares, E-28871 Madrid, Spain*

ABSTRACT.—The use of refuse by breeding, floating, and migrating Black Kites (*Milvus migrans*) was studied near a large garbage dump in Madrid, Spain. Refuse was an important food resource for nonbreeding Black Kites, especially migrants that fed almost exclusively at the garbage dump. The dump was only of secondary and variable importance for kites during the breeding season. Pairs of breeding kites nesting in nearby wooded areas foraged mainly on a wide variety of wild prey and only sporadically ate refuse at the dump. Floaters roosted in nearby wooded areas but, unlike breeding pairs, they foraged mainly by scavenging at the dump. Exploitation of food resources other than refuse by breeding kites may be due to their need for large amounts of prey biomass for brood provisioning. Perhaps dumps augment populations of Black Kites by providing rich foraging areas where large numbers of nonbreeding and migratory kites can scavenge for food.

KEY WORDS: *Black Kite;* Milvus migrans; *garbage dump; foraging; refuse.*

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Importancia de la basura en la dieta de Milanos Negros (*Milvus migrans*) migrantes, flotantes y reproductores.

RESUMEN.—La importancia de la basura en la dieta de Milanos Negros (*Milvus migrans*) reproductores, migradores e integrantes de la poblacion flotante fue estudiada en las cercanías del basurero de Madrid, España. La basura fue un recurso importante para los milanos no reproductores, especialmente para los migrantes, pero su papel fue secundario aunque variable para los milanos que se reprodujeron cerca del basurero. Los individuos flotantes forrajearon en el basurero pero tambien consumieron una amplia variedad de presas salvajes. La abundancia de alimento en el basurero no provocó que los milanos nidificaran en sus cercanias, ya que la parejas que así lo hicieron consumieron basura sólo esporádicamente. Por el contrario, los individuos flotantes percnoctaron a diario en la zona arbolada más cercana al basurero. El uso preferencial de presas salvajes frente a la basura por los milanos reproductores puede ser explicado como consecuencia de la necesidad de presas de gran biomasa para su consumo por los pollos en crecimiento. Durante la estación reproductora, el vertedero de Madrid podría tener una importancia indirecta para el mantenimiento y conservación de la población reproductora a través del reemplazo de las pérdidas en los reproductores por los individuos flotantes.

[Traducción del Autor]

Breeding and nonbreeding segments of raptor populations often share the same foraging habitats (Newton 1979). Floaters, nonbreeding, nonterritorial adults and subadults, have larger home ranges and greater mobility than breeders, and usually concentrate in areas rich in food (Newton 1979, Ceballos and Donázar 1990). Interactions between floaters and breeding conspecifics has been little studied despite its potential to influence raptor population dynamics (Newton 1979). Both breeders and floaters of social species such as the *Milvus* kites coexist in breeding areas when food is abundant (Espina 1986, Koga et al. 1989, Heredia et al. 1991), especially where large waste accumulations occur at garbage dumps (Ceballos and Donázar 1988, Blanco 1994). Rubbish dumps and dungheaps are frequently used by scavenging birds that normally exploit temporary and unpredictable food sources (Pomeroy 1975, Donázar 1992). The importance of refuse dumps for breeding populations of scavenging birds has been repeatedly emphasized (Pomeroy 1975, Coulson et al. 1987, Donázar 1992) but, to date, it is not known whether these unnatural foraging places are influencing the population dynamics of scavenging species.

The Black Kite (*Milvus migrans*) is a widespread species that opportunistically exploits a wide array of food sources (Delibes 1975, Shiraishi et al. 1990). Floaters form an unknown proportion of populations, and usually share habitat with the breeding segment (Espina 1986, Koga et al. 1989, Blanco 1994). At present, little is known about the relationship between these two sectors of Black Kite populations. This study deals with the role of refuse in the diet of breeding, floating and migrating Black Kites living in the vicinity of a large garbage dump near Madrid, Spain.

## STUDY AREA AND METHODS

The study area was located at an elevation of 500–700 m in the flood plain of the Jarama River at its confluence with River Manzanares (40° 19'N, 3° 31'W) in southeastern Madrid Province, central Spain. It included a complex of riverine gypsum cliffs, riparian forests dominated by poplars (*Populus alba, P. nigra, P.* × *cultivar*), willows (*Salix* spp.) and elms (*Ulmus minor*), but most of the area was converted to agriculture (mainly cereal crops, sunflower, alfalfa and vegetables), cattle grazing and gravel extraction. The Madrid garbage dump was located in the northeastern portion of the study area. From 100 to >1000 Black Kites routinely gathered there to feed on the refuse (Blanco 1994).

During the breeding season of 1994, the Black Kite population consisted of about 50 pairs nesting on trees, cliffs and electric pylons, and about 80–300 nonbreeding individuals forming a floating population of both adults and subadults (Blanco 1994). Each day, resident floaters roosted communally about 4 km southeast of the dump, in a portion of riverine elm forest where 6–10 pairs nested Numbers of Black Kites in the area increased considerably after breeding and especially during migration (Blanco 1994).

I determined the diet of nonbreeding kites by analyzing food remains collected beneath roosting and diurnal communal perching trees during the period when Black Kites are resident in the area (Blanco 1994). All prey remains (bones, fur and feathers) were collected on each visit to the roost, from the final stage of the nestling period (June) to the end of August. Prey collections were grouped into three time periods (22 July, 31 July and August) to assess possible temporal variations in the consumption of refuse. The first period (Period A: until 22 July) included the spring migration, breeding season, fledgling period and the start of migrant arrivals; Period B (23–31 July) coincided with an increase in the influx of migrants; and Period C (from 1 August to the end of that month) included the peak abundance of migrants and the remainder of the residency period of Black Kites in the area (Blanco 1994). Because all food remains found below the roosting trees were collected in each visit to the roost, I am confident that they were accurately grouped on a temporal basis. Because breeding Black Kites usually roosted close to their nesting sites during the breeding period, prey remains found at the communal roost site were mostly from food eaten by local nonbreeders. Prey remains found at the roost after the breeding season corresponded to food of both local (breeding and floating) and migrant kites. After the breeding season, field observations suggested that breeding Black Kites and their fledglings joined communal roosts together with floaters and northern migrants (J. Viñuela pers. comm. and pers. obs.). The first juveniles appeared in the roost soon after the breeding season (Blanco 1994) when breeders left their territories. Therefore, some remains collected at this time might have originated from prey of local breeders which represented a high proportion of the birds roosting communally from 23–31 July. Afterwards, the collecting period coincided with the major influx of migrants (>1000 kites in early August); at this time local breeders constituted a small proportion of the birds.

The diet of breeding kites and their nestlings was determined by analysis of food remains found in and below the nests of 18 pairs. The material was collected after the breeding season to avoid disturbance at the nests. Pairs studied nested in trees and cliffs about 4–12.5 km from the dump.

Food remains were identified by macroscopic comparison with reference collections and quantified assuming the smallest possible number of individuals (Marti 1987). Two main categories of food were considered in the analysis: wild prey obtained by hunting and scavenging (e.g., wild birds, mammals, fish), and refuse (e.g., food items intentionally discarded by humans such as domestic refuse, offal from slaughterhouses and butcher shops, and marine fish). To detect general differences in food habits of breeding and nonbreeding Black Kites, prey items were classified into nine major groups (Table 1). The data were likely biased in favor of the most durable prey remains and did not reflect the importance of arthropods and other prey (Marti 1987). However, the study was not designed to provide detailed descriptions of the Black Kite diet (Delibes 1975, Veiga and Hiraldo 1989, Shiraishi et al. 1990) but to detect broad differences in the consumption of refuse.

Biomass of each prey species was estimated using mean weights of each prey taxon obtained from the literature. Weights of prey taxon identified at nests could not exceed 300 g even when the mean weight of the taxon exceeded that weight because Black Kites usually do not transport heavier prey to the nest (Espina 1986, pers. obs.). In this case, I assumed that prey heavier than 300 g were not delivered to the nest whole. Weights of large prey from the roost were estimated based on the daily food requirements of adult Black Kites (100 g, Espina 1986; see also Heredia et al. 1991 for Red Kites [*Milvus milvus*]). Therefore, I assumed that the maximum ingestion capacity per feeding bout to be equivalent to the daily food requirements (Blanco et al. 1990). Although Black Kites may tear off small pieces of the prey and bring them to the nest one by one (J. Viñuela pers comm.), and nonbreeding kites may eat prey over several days, I felt my criteria avoided an overestimation of the biomass of large prey up to the size of a White Stork (*Ciconia ciconia*, weight = 3.5 kg).

Refuse consumed both by breeding and nonbreeding kites typically consisted of small pieces of food, including parts of fish and fowl (mostly heads, wings and legs) and livestock bones, but no large fragments of food, which was estimated to yield 50 g of biomass on average. Be-

Table 1. Diets of breeding and nonbreeding Black Kites in the southeast of Madrid during and after the breeding season of 1994. Results are expressed as percentages of number of prey (NP) and biomass (B) for each prey class.

| | Breeding Black Kites | | Non-Breeding Black Kites | | | |
|---|---|---|---|---|---|---|
| | | | Breeding Season | | Nonbreeding Season | |
| Prey Items | % NP | % B | % NP | % B | % NP | % B |
| Wild prey | 76.4 | 93.1 | 40.6 | 57.4 | 21.4 | 29.4 |
| Rabbits and Hares[a] | 22.5 | 39.7 | 18.8 | 26.9 | 8.7 | 16.3 |
| Other mammals[b] | 6.0 | 4.9 | 3.1 | 4.5 | 1.0 | 1.8 |
| Pigeons[c] | 8.8 | 15.5 | 3.1 | 4.5 | 2.9 | 5.4 |
| Other birds[d] | 18.7 | 21.1 | 12.5 | 17.0 | 2.9 | 5.4 |
| Fish[e] | 13.2 | 11.0 | 3.1 | 4.5 | 0.0 | 0.0 |
| Other prey[f] | 7.1 | 0.9 | 0.0 | 0.0 | 5.8 | 0.4 |
| Refuse | 23.6 | 6.9 | 59.4 | 42.6 | 78.6 | 70.6 |
| Livestock carrion | 17.0 | 5.0 | 37.5 | 26.9 | 48.5 | 42.6 |
| Chicken | 5.5 | 1.6 | 18.8 | 13.5 | 22.3 | 20.8 |
| Marine fish | 1.1 | 0.3 | 3.1 | 2.2 | 7.8 | 7.2 |
| Number of prey | 182 | | 32 | | 103 | |
| H′ | 0.87 | | 0.73 | | 0.66 | |

[a] *Oryctolagus cuniculus, Lepus granatensis.*
[b] *Erinaceus europaeus, Rattus norvegicus, Apodemus sylvaticus,* unidentified rodents.
[c] *Columba livia, Columba livia* var. *domestica, Columba palumbus,* unidentified pigeons.
[d] *Ciconia ciconia, Anas platyrhynchos,* unidentifeid Anatidae, *Milvus migrans, Alectoris rufa, Gallinula chloropus, Larus ridibundus, Clamator glandarius, Otus scops, Athene noctua, Picus viridis, Sturnus unicolor, Pica pica, Corvus monedula,* unidentified corvid, *Turdus merula, Passer* sp., unidentified bird.
[e] *Cyprinus carpio, Ictalurus melas,* unidentified fish.
[f] *Lacerta lepida,* unidentified Colubridae, unidentified Coleopterans, bird eggs.

cause of the difficulty in accurately estimating biomass values from prey remains of scavengers and facultative predators (Marti 1987), the analysis conducted in this respect should be considered as a simple approximation of the diet. The aim of the biomass analysis was provide a comparative assessment of the energetic role of refuse with the natural prey for breeding and nonbreeding kites.

Dietary diversity was calculated with the Shannon-Weaver index (H′) considering the major prey classes (Table 1). Dietary overlap between breeding and nonbreeding kites was calculated using Pianka's index (Pianka 1973). Chi-square tests with Yates' correction when df = 1, were used to test for differences in the number of prey items (NP) consumed by breeding and nonbreeding kites.

## RESULTS

**General Food Habits.** The diet of Black Kites included a wide range of wild prey and refuse (Table 1). Up to 300 nonbreeding kites returned to the roost every day from the garbage dump throughout the breeding season. Most of the food they obtained from the dump was small pieces of domestic refuse and slaughter offal (*Ovis, Sus, Bovis, Gallus*) which was spread fairly evenly over large amounts of inorganic materials because of the daily treatment measures at the dump. Unidentified marine fishes, available only at the dump, were also consumed. Wild prey consumed by nonbreeders included mostly European rabbits (*Oryctolagus cuniculus,* NP = 34.3%, B = 41.4%), but hares (*Lepus granatensis*) and pigeons (*Columba* spp.) also were of some importance.

Breeding kites ate mainly wild prey (Table 1), the main prey species being European rabbits (NP = 18.7%, B = 32.9%). Altogether, birds accounted for 27.5% by NP and 36.6% by B, and they were mostly medium-sized corvids and pigeons.

**Spatial Variation in the Consumption of Refuse by Breeding Kites.** The roost site used by nonbreeding kites was 4 km from the dump. Pairs nesting near the roost site had a higher proportion of refuse in their diets than did pairs that nested 5.1–12.5 km from the dump ($\bar{x} \pm$ SE = 6.6 ± 0.6 km; $\chi^2 = 12.53$, df = 1, $P < 0.001$ for NP; Fig. 1). However, there was variation in the consumption of refuse among pairs that nested close to the dump (18.2–72.7% of NP, Fig. 2), with somewhat lower values for biomass (5.4–30.8%, Fig. 1).

Although some kites probably obtained refuse at

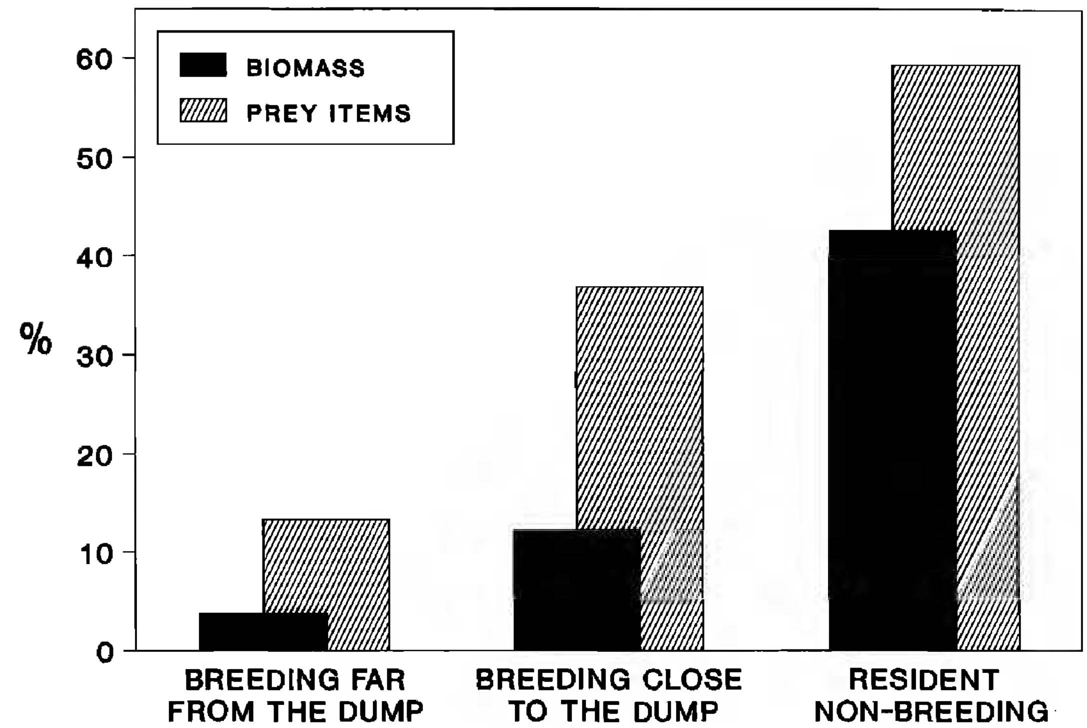


Figure 1. Percentage of refuse in the diet of Black Kites. Data are presented for resident floaters and for kites nesting either far or close to the garbage dump of Madrid, respectively.

sites other than the dump, the proportion of refuse in the diet of breeding pairs was negatively related to distance to the dump (Spearman rank correlation coefficient $r_s = -0.64$, $P = 0.0087$ and $r_s = -0.70$, $P = 0.0038$ for %NP and %B, respectively, $N = 18$, Fig. 2). Thus, the proportion of refuse in the diet of breeding Black Kites was variable for those pairs breeding in the vicinity of the dump but almost insignificant in terms of biomass for the remainder of the breeding population.

**Diet Differences and Overlap within the Local Population.** The proportion of prey remains included in the refuse class was significantly higher for nonbreeding than for breeding kites (100 of 135 vs. 44 of 182, $\chi^2 = 75.84$, df = 1, $P < 0.001$). A similar conclusion was reached by comparing food remains from the breeding season only, both for all nests ($\chi^2 = 14.58$, df = 1, $P < 0.001$ for NP) and when nests located close to and far from the roosting area were considered separately ($P < 0.05$ in all cases, Fig. 1). I found a higher overlap in the diets of breeding Black Kites for prey biomass than for prey type (Table 2). Nonbreeding floaters showed a higher overlap with kites breeding close to the dump than with those breeding farther away, both in type and biomass of the prey they con-

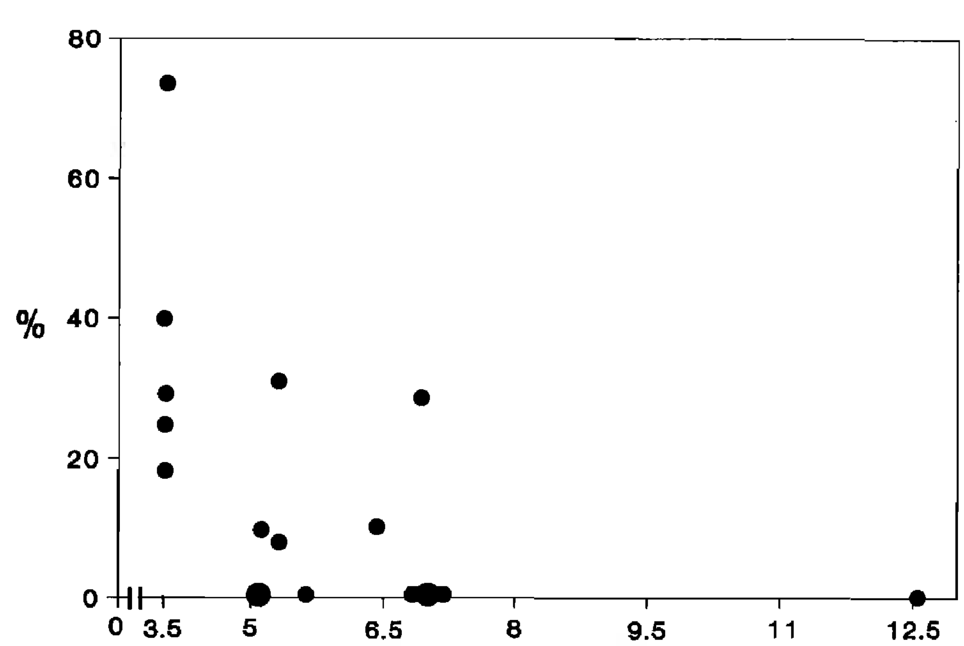


Figure 2. Proportion of prey from refuse in the diet of breeding Black Kites ($N$ = 18 pairs) in relation to the distance of their nest from the garbage dump of Madrid. Large dots represent two nests.

Table 2. Percentage of diet overlap (Pianka's index) between breeding and nonbreeding Black Kites.

| | % OF DIET OVERLAP | |
|---|---|---|
| COMPARISONS | NUMBER OF PREY | BIOMASS |
| Breeding close vs. far from the dump | 69.8 | 86.0 |
| Breeding close vs. nonbreeding | 91.0 | 80.9 |
| Breeding far vs. nonbreeding | 55.6 | 70.8 |

Table 3. Seasonal variation in the consumption of refuse by nonbreeding Black Kites, expressed as percentage of number of prey items (NP) and biomass (B).

| Period | % B | % NP | H' | n |
|---|---|---|---|---|
| A (to July 22) | 42.6 | 59.4 | 0.73 | 32 |
| B (23–31 July) | 64.7 | 69.8 | 0.66 | 43 |
| C (August) | 75.0 | 85.0 | 0.60 | 60 |

sumed. Nevertheless, dietary overlap was high in all the comparisons as expected for individuals of the same species.

**Seasonal Variation in the Consumption of Refuse by Non-breeding Kites.** Refuse was the main food for nonbreeding kites (Table 3). However, the proportion of refuse increased as the season progressed from the breeding season, when most kites gathering at the roost belonged to the local nonbreeding population, toward the end of the collecting period when most kites were migrants ($\chi^2 = 7.75$, df = 2, $P = 0.02$ for NP; Table 3). As a result, dietary diversity declined as the season progressed.

## DISCUSSION

In this study, refuse was a more important food resource for Black Kites, especially nonbreeding and migrant individuals. Floaters roosted in wooded areas near the dump and consumed refuse almost extensively and very seldom taking wild prey. Apparently they were able to exploit this abundant and predictable food source because their movements were not restrained by breeding. Contrastingly, breeding Black Kites fed mostly on wild prey items but there was a significant correlation between the distance of nests from the dump and the consumption of refuse with pairs nearest the dump increasing their consumption of refuse. Preferential use of natural food sources by breeding Black Kites is probably related to constraints placed on breeding kites by the need to provision broods of developing young with adequate prey biomass (Donázar 1988, Viñuela and Veiga 1992). In addition, high percentages of rubbish/carrion in the diet could negatively affect the growth of young (Hiraldo et al. 1990, Viñuela 1991).

After the breeding season, refuse is also used by local breeders and their fledglings. Inexperienced juveniles benefit greatly by using the dump and by group foraging at a place where several hundreds of kites feed together.

The presence of floaters may enhance the breeding population of a species by providing a mechanism for quick replacement of lost mates at nest sites. Through their support of juvenile and subadult, nonbreeders, garbage dumps may provide a mechanism of increasing the survival and recruitment of breeding individuals into the populations of scavenging birds. Indeed, garbage dumps have been highlighted for their potential importance in the conservation of Black Kite populations, especially during migration (Donázar 1992, Blanco 1994).

## ACKNOWLEDGMENTS

I thank A. Acha, L. Blanco, M.C. Blanco, J.A. Fargallo, F. Gómez, F. Martínez and E. Soto-Largo for help with the field work. J.L. Tella discussed some aspects of the work and helped me with the analysis of data, and J. Viñuela, C.D. Marti, J. Bustamante and an anonymous referee provided many useful comments on the manuscript.

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Received 10 April 1996; accepted 16 November 1996